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Effects of Worksheets on Problem-Solving Skills: Meta-Analytic Studies

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Abstract: The purpose of this study was to compile and statistically analyze the results of research studies that examined students' problem-solving skills in worksheets. The research method used was a meta-analysis. The study search was conducted from 2013 to 2022 in Google Scholar and the Garuda portal databases. The search yielded 40 studies that met the inclusion criteria for extraction from research and development, experimental, and quasi-experimental. From the extracted results, 45 comparisons of data were examined. Microsoft Excel was used to calculate the effect size of the problem-solving worksheet. This study yielded a value of 1.281 for the entire study, indicating that the worksheet had a significant and positive impact on students' problem-solving skills. The results indicate the need to develop worksheets to improve students' problem-solving skills.

Keywords: *Effect, meta-analytic, problem-solving skill, worksheet.*

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Introduction

Classroom learning requires worksheets for students to supplement the learning experience (Avila, 2015; Lai et al., 2015; McLaughlin et al., 2014; Sepulveda-Escobar & Morrison, 2020). Worksheets are learning tools that provide instructions on tasks or the work a student needs to complete (Ekantini & Wilujeng, 2018; Hartini et al., 2020; Yulkifli et al., 2019). A worksheet is a guide for students to learn a concept so that they can solve a problem (Atmatzidou & Demetriadis, 2014; Djamas et al., 2018). The worksheet's purpose is to support and facilitate teaching and learning activities, so good interaction between students and educators can improve student learning and learning outcomes (Mihardi et al., 2013; Urhahne et al., 2010). The use of worksheets in learning is expected to encourage students to be more active (Marian & Suparman, 2019; Putra et al., 2018), enhance students' creativity (Krisdiana et al., 2019; Mihardi et al., 2013), and sharpen their critical thinking in problem-solving (Hartini et al., 2020; Yasin et al., 2019).

The use of printed worksheets, which we typically encounter in face-to-face learning, appears less relevant during the current COVID-19 pandemic. During the pandemic, teachers rely more on distance learning using learning management systems or other platforms supporting the learning process (Cicha et al., 2021; Nakamura et al., 2018; Setiawan, 2020). Face-to-face learning has been taking place in several schools during this time. However, teachers' instruction for learning that occurs offline, online, or hybrid requires worksheets (Hediansah & Surjono, 2020; Irsalina & Dwiningsih, 2018; Syarifah & Wh, 2022; Yonata & Novita, 2021). For this reason, the existence of worksheets must be acknowledged by teachers to support the learning process in the classroom.

Many researchers have studied worksheets with students' hard and soft skills. Previous studies show that worksheets can improve students' activities and learning experiences with geometry materials (Utami et al., 2016). Other research shows that worksheets can improve students' higher-order thinking skills (Marshel & Ratnawulan, 2020). Worksheets can improve students' critical thinking skills (Sujatmika et al., 2019), including problem-solving skills (Ibrahim et al., 2017; Nuralifah & Hidayah, 2021; Rodli et al., 2022; Rosidah, 2013). Their research shows that worksheets remain

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central to educational research, making worksheet-related research a strength in academic research now and in the future. This aspect is the first strength of a study on worksheets.

The second strength is that worksheets are different from other learning media. Since worksheets can be used as a primary learning resource alongside the teacher, worksheets can become learning centers in the classroom. In addition, research also focuses on the use of worksheets as a supplement to the learning strategies used by teachers. The worksheets created by the researchers usually include materials for assignments, group discussions, and student evaluation tools. Previous research has shown that worksheets can support problem-based learning (Choo et al., 2011). Some researchers have even developed worksheets that can be used in the classroom, such as learning with Google Forms (Simanjuntak & Limbong, 2018) combined with augmented reality videos (Bakri et al., 2020), worksheets with a guided inquiry learning approach (Misbah et al., 2018), and creating worksheets integrated with math comics (Widyastuti et al., 2017).

However, the research conducted by the previous researchers is still scattered when considering the observed variable. In this case, the student's ability to explore the worksheet must be summarized based on the student's ability to determine the effect size, providing an overview of the magnitude of the worksheet's influence (independent variable) on students' skills (dependent variable). The lack of effect size, including a summary of the results of (at least) two studies to combine, review, summarize, and describe the magnitude of the effect of worksheets on students' skills from the results of previous studies, is a weakness of the existing studies in the literature.

The worksheet is a part of the learning media. Worksheets are one form of educators' efforts to make learning more meaningful and to improve students' cognitive skills. Worksheets will likely enhance these skills, including learning outcomes, problem-solving, critical thinking, and creative thinking skills. Problem-solving is a skill that students must possess to perform well. However, previous studies show that the results still need improvement. This finding is evident from the results of a 2015 TIMSS (Trends in International Mathematics and Science Study) survey of 15-year-old students, who scored 397 (Kartianom & Retnawati, 2018; Mullis et al., 2012; Mullis & Martin, 2015; Mullis et al., 2015). Similarly, for the PISA (Program for International Student Assessment) scores, which measure reading, mathematics, and science literacy skills, the average scores in 2015 were 397, 386, and 403, respectively, still below the international average score of 500 (Ismail et al., 2018; Lastiningsih et al., 2017).

Problems can occur when students do not have rules to overcome the gaps in the situation with the goals to be achieved (Hmelo-Silver, 2004; Tawfik et al., 2015; Widodo & Turmudi, 2017). To prevent this gap, students can use all their knowledge or search for information related to the problems (Kiecolt-Glaser et al., 2002). The problem can be solved or answered by using all the potential available. When the process of accommodation, adaptation, and assimilation between the ancient knowledge embedded in the student's mind and the new expertise occurs in balance or equilibration, the student can be said to be capable of problem-solving (Widodo & Turmudi, 2017; Widodo, Turmudi & Dahlan, 2019). However, if there is no balance between old and new knowledge, students cannot adopt the latest knowledge and, therefore, become incompetent in problem-solving (Widodo & Turmudi, 2017).

Troubleshooting can be done in several steps: identifying the problem, establishing a plan to solve the problem, implementing the project, and reviewing the previous steps (Polya, 1973; Widodo et al., 2020). Since time immemorial, many researchers have sought to overcome students' problem-solving skills. They attempted to overcome the problem of students' problem-solving skills by linking and modeling the concept with the surrounding culture (Biembengut, 2016; Peranginangin et al., 2019; Simamora et al., 2018). They use multiple representations through virtual manipulation and a whiteboard system (Hwang et al., 2009). In addition, visual media can improve problem-solving ability (Widodo et al., 2018; Widodo, Irfan, et al., 2019). Students can construct concepts using worksheets by optimizing visual representations (Begolli & Richland, 2016; Cai & Wang, 2006; Rau & Matthews, 2017).

Previous studies attempted to use tools such as culture in the students' environments, virtual manipulation, visual media, visual representations, and worksheets to enhance students' problem-solving skills. These tools are one of the strengths of previous research on problem-solving. In addition to problem-solving, this tool is still a trending topic in educational research in the present and future. They suggest that many options can be used to improve problem-solving skills. However, the overall picture of the factors influencing problem-solving skills needs to be clarified. This problem is the biggest weakness of previous research.

There are many ways to measure problem-solving skills, as Widodo and Turmudi (2017), Widodo et al. (2018, 2020), and Widodo, Irfan, et al. (2019) have done using Polya's four steps of (a) understand the problem, (b) design a plan, (c) carry out the play, and (d) look back. They even used Polya's steps to develop a scoring rubric for problem-solving ability. This rubric is a strength based on the research they conducted. However, when this rubric has been used to measure problem-solving skills with other steps, such as by Bransford and Stein (1993), Dominowski (2002), and Wickelgren (1974), the rubric is inevitably inappropriate for use. For this reason, the developed rubric must be adapted and modified. Although, the steps to address the issues raised are generally the same as in Polya's opinion. Regardless of the strengths and weaknesses of the research, researchers agree that the ability to solve problems is an essential requirement for students.

The Research Problem

Among the problems of this research is the ability of students to solve problems that need improvement for teachers and education policymakers. This problem is evident from a survey conducted by international institutions such as PISA and TIMSS. Second, during the COVID-19 pandemic, most of the learning devices used could not become tools or media teachers could use for online learning because the teaching materials created by teachers were still in paper form and thus not visible. Third, the research findings related to worksheets revealed that this tool could improve students' cognitive skills, such as problem-solving. Associated with this condition, the research problem in this study is whether previous studies related to worksheets affect students' problem-solving abilities.

Based on the research problem, the purpose of this study is to determine the effect or influence of worksheets on problem-solving skills. A meta-analytic approach was used in this study by looking at the different forms of worksheets and measuring problem-solving skills as one of the observed variables in previous studies that used different instruments and methods. The authors of this paper conducted a limited synthesis study over the last decade (2013-2022) using the worksheet and problem-solving. This research is important to know the impact of the worksheet on overall problem-solving ability over the last decade.

This study aimed to use meta-analysis to meet the objectives of this study and address the weaknesses of previous studies that were unable to describe the magnitude of the influence of worksheets on problem-solving skills. The use of meta-analysis yields effect sizes that combine the results of (at least) two studies. In doing so, the magnitude of the effect of worksheets on student skills was reviewed, summarized, and described using the results of previous studies that represent the weaknesses of those studies.

Methodology

Research Design

A meta-analysis method was used in this study. This research was conducted by reviewing several articles in national and international journals and national and international proceedings. Because this study is meta-analytical, this study does not experiment with a model on students' cognitive effects, namely problem-solving ability. The meta-analysis aims to combine and statistically evaluate the results of independent studies testing the use of worksheets on problem-solving skills. The meta-analysis methods provide an overall assessment through statistical analysis of quantitative data obtained from separate studies on a particular topic (Borenstein et al., 2009; Kyndt et al., 2013; Park et al., 2016). Effect size is a simple way to measure the difference between two groups and has many advantages over statistical significance alone (Suurmond et al., 2017; Szucs & Ioannidis, 2021; Tomczak & Tomczak, 2014). A meta-analysis study follows these steps. First, identify the problem and, second, search the internet for literature on the problem using a search engine (Borenstein et al., 2009; Park et al., 2016). The studies in the literature were coded according to specific criteria. After this stage, statistical analyses were carried out, and the findings were interpreted.

Literature Search

The criteria for the articles used for this meta-analysis research are the results of research involving worksheets and problem-solving skills. There was a literature search regarding worksheets and problem-solving skills by Wijayanti, she is an expert in worksheets and science. The consequences of these studies have been published in journals or proceedings. Researchers use search engines such as Google Scholar to find the article by writing down keywords, namely worksheets and problem solving. Search results using Google Scholar were obtained from more than 85,000 studies.

Inclusion and Exclusion Criteria

After obtaining the literature from the previous stage, we apply inclusion and exclusion criteria. Pusporini, an evaluation expert, determines the selected literature at this stage. The result of prior studies used in this study was selected from research and development, experimental and quasi-experimental, with the focus of the research being on increasing the ability to solve mathematical problems using worksheets. The studies included in the limited synthesis were carried out in the last decade (2013-2022). The articles used for the synthesis must describe the data, such as the study sample size, mean, and variance (Borenstein et al., 2009; Vowles et al., 2015). In addition, synthesis articles need to be considered for writing statistical test results such as t, F, or r test results (Cooper et al., 2019). Based on this detail, the inclusion criteria used were (1) the research involved worksheet variables and problem-solving skills, (2) the period of the publication was carried out, (3) the published articles had a description of the data such as study sample size, mean, variance, and results test statistics. Based on these criteria, forty (40) studies were included in this study. However, as several studies used multiple experimental or control groups, forty-five (45) data comparisons were examined. This study does not use exclusion because the articles used come from one of the indexing sources, namely Google Scholar.

Coding Data

Based on the 40 selected literature, we need to categorize/code them to make it easier to analyze. At this stage, Irfan is responsible for making categories and has experience in qualitative research and making codes. This meta-analysis tool or research instrument used the coding category sheet (Borenstein et al., 2009; Cooper et al., 2019). The coding format is based on predetermined characteristics such as researcher name, year of study, study group, sample size, and type of mathematical software used. In addition, the coding form also contains sample sizes, mean, and standard deviation values for the two groups. This form of coding was developed to improve reliability in the suitability of relevant studies. Table 1 shows information about this study.

Table 1. Information Subject of Research

No	Characteristic		f
1	Publication Year	2013-2015	4
		2016-2019	17
		2020-2022	19
2	Education stage	Primary School	6
		Junior High School	16
		Senior High School	18
3	Sample size	Large Sample (>30)	36
		Small Sample (<30)	4
4	Technique of sampling	Random	24
		Purposive	16

In this study, reliability was not carried out statistically. In other words, researchers did not consider the reliability of articles that had been published in journals or proceedings of a seminar. The researcher justifies that before being published in journals or proceedings, the papers have undergone a series of review processes by reviewers in their fields. This process is one of the weaknesses of this research. In addition, in this study, reliability was not carried out statistically. However, this was done with justification from the researcher. We believe that the articles used have undergone a lengthy assessment process from journal editors and reviewers before the article is published in the journal or proceedings.

Analysis

Data analysis in the meta-analysis was carried out by (a) calculating the effect size, (b) transforming the value from F to t and r, and (c) estimating the impact of sampling. In this stage, Widodo is in charge and experienced in quantitative research and statistical tests. To determine the value of the effect size, the formula from Cohen (Celikbas & Dao, 2014; Goulet-Pelletier & Cousineau, 2018; Levi et al., 2020) is

$$ES = \Delta = \frac{\overline{X_e} - \overline{X_c}}{S_c}$$

Where $\overline{X_e}$ is the average value of the experimental group, $\overline{X_c}$ is the average value of the control group, and S_c is the standard deviation of the control group. There is no information about the standard deviation of the control group. In that case, the average value of the experimental control groups and the effect size derivative formula can be used, as shown in Table 2 (Borenstein et al., 2009; Cooper et al., 2019; Kelter, 2020; Kim, 2017).

Table 2. Effect Size Calculation for Z-test, t-test, r-test, F-test and χ^2 test

Type of test	effect size formula	description
Uji-Z	$ES = Z\sqrt{\frac{1}{n_e} + \frac{1}{n_c}}$	Z : z-test score n_e : the number of samples from the experimental group n_c : the number of samples of the control group
Uji-t	$ES = \sqrt{\frac{2t}{N}}$	t : t-test score N : Number of samples
	$ES = t\sqrt{\frac{1}{n_e} + \frac{1}{n_c}}$	t : t-test score n_e : the number of samples from the experimental group n_c : the number of samples of the control group
Uji r	$ES = \frac{2r}{\sqrt{1-r}}$	r : r-test score
Uji-F	$ES = F\sqrt{\frac{2}{n}}$	F : F-test Score n : Number of samples
Uji χ^2	$ES = \frac{\sqrt{\chi^2}}{n}$	χ^2 : χ^2-test score n : Number of samples

The results of the effect size calculation are compared with the criteria as shown in Table 3 (Glass, 1977; Setiawan et al., 2022).

Table 3. Criteria of Effect Size

Range	Criteria
$-0.15 \leq ES < 0.15$	No level
$0.15 \leq ES < 0.40$	Low level
$0.40 \leq ES < 0.75$	Moderate level
$0.75 \leq ES < 1.10$	High level
$1.10 \leq ES < 1.45$	Very high level
$ES \geq 1.45$	Excellent level

Transform the score of F into the score t, and r score can be done with the formula the $t = \sqrt{F}$ dan $r_{xy} = \frac{t}{\sqrt{t^2+(N-2)}}$. Calculating the impact of sampling can be done using the bare-bones meta-analysis method (Borenstein et al., 2009; Cooper et al., 2019; Nunnery et al., 2013).

Results

Effect Size

From 40 research articles used as research subjects, 45 comparisons of data were examined, which can be grouped into two groups, namely the first group of papers with known average, standard deviation, and several samples (see Table 4), so that the effect size can be determined using Cohen's formula.

Table 4. Group of Articles with Known Mean, Standard Deviation, and Number of Samples

Author	Years	Experiment			Control			Effect size
		Mean	Std. Dev	n	Mean	Std. Dev	n	
Karatas and Baki	2013	9.346	1.547	26	8.157	1.321	27	.90
Karatas and Baki	2013	8.942	2.421	26	8.481	1.547	27	.30
Rosidah	2013	85.97	11.831	33	81.34	11.487	34	.40
Zakaria and Hidayah	2015	78.10	14.328	36	71	16	34	.44
Asigigan and Samur	2021	92.26	11.96	12	89.65	9.42	12	.28
Herdiana et al.	2017	79.28	9.38	36	63.21	16.09	36	1.00
Wahyuni et al.	2018	65.81	17.84	27	50.13	18.2	30	.86
Bahri et al.	2018	83.93	5.8	30	78.8	80	30	.06
Laili et al.	2019	29.50	4.463	36	26.406	5.327	32	.58
Suarsana et al.	2019	71.55	9.769	40	63.4	12.884	40	.63
Suarsana et al.	2019	78.36	9.634	39	63.4	12.884	40	1.16
Afridiani et al.	2020	12.50	3.808	36	11	2.808	35	.53
Ismail et al.	2020	81.46	9.69	32	55	9.58	32	2.76
Simbolon	2020	81.87	15.25	30	55.13	17.56	30	1.52
Budikusuma et al.	2021	80.49	7.023	33	41.6	11.417	33	3.41
Febria Sari et al.	2021	81.70	8.4	30	74.7	7.3	30	.96
Puspita and Dewi	2021	70.37	9.36	34	20.1	8.94	34	5.62
Saraswati et al.	2021	78.07	10.586	14	66.93	11.228	14	.99
Suriani and Devita	2021	83.22	11.14	32	74.48	12.17	31	.72
Amin et al.	2021	75.45	14.68	94	70.45	14.68	94	.34
Juhaeriah et al.	2021	79.63	6.9	30	77.87	5.44	30	.32
Fauziah et al.	2022	78.00	11,341	30	68,17	12,281	30	.29
Tamami et al.	2017	56.44	11.629	35	41.87	14.982	35	.97
Fitriyani et al.	2019	72.22	8.76	36	46.45	13.36	36	1.93

Second, the group of articles for which the mean or standard deviation is unknown, but the statistical results of the t, F, r tests and the sample size used (see table 5) can be determined so that the effect size can be determined using the formula as shown in Table 5.

Table 5. The Group of Articles is Known for the Statistical Results of the t, F, and r Tests and the Sample Size Used

Author	Year	*F*	*t*	Effect size
Mawarti et al.	2018	6.674	-	1.38
Sari, Syaiful, and Anggereini	2021	2.955	-	.56
Budiono and Wardono	2014	-	2.57	.73
Ibrahim et al.	2017	-	7.091	1.66
Fitri et al.	2017	-	2.773	.69
Mawarti et al.	2018	-	2.36	.69
Utami	2016	-	.18	.05
Divrik et al.	2020	-	3.14	.98
Divrik et al.	2020	-	4.48	1.37
Divrik et al.	2020	-	2.43	.75
Dinda et al.	2021	-	24.1	6.82
Kahar et al.	2018	-	32.806	3.65
Febriani et al.	2019	-	4.983	1.14
Febriani et al.	2019	-	2.919	.67
Huda et al.	2020	-	4.013	1.14
Nuralifah and Hidayah	2021	-	17.23	6.76
Rodli et al.	2022	-	1.839	.82
Syafwan et al.	2016	-	5.32	.34
Kuswanto et al.	2017	-	1.774	.11
Susanti et al.	2022	-	2.468	.15
Helmi et al.	2017	-	2.880	.18
Diana and Makiyah	2021	-	21.1	1.28

From Tables 4 and 5, it is found that the average effect size is 1.281. This effect size is at a very high level.

Transform the Score of the F-test and t-test into r Value

From the results of the studies used as samples in this meta-analysis, it is known that five studies have known F values, 34 studies have known t values, and the rest are known for r. For this reason, all study results known as F and t need to be first transformed into r values (see Table 6).

Table 6. Transform the Score of the F-test and t-test into r value

Author	Year	N	F	t	r	$(r-\check{r})^2$	$N \times r$
Karatas and Baki	2013	53	-	3.011	.389	0.0007	20.59
Karatas and Baki	2013	53	-	.836	.116	0.0895	6.16
Rosidah	2013	67	-	1.71	.207	0.0432	13.90
Zakaria and Hidayah	2015	70	-	7.417	.669	0.0642	46.81
Asigigan and Samur	2021	24	-	2	.392	0.0005	9.41
Herdiana et al.	2017	72	-	–.509	–.061	0.2267	-4.37
Wahyuni et al.	2018	57	-	.061	.008	0.1658	0.47
Bahri et al.	2018	60	7.121	2.669	.331	0.0072	19.84
Laili et al.	2019	68	-	2.605	.305	0.0121	20.77
Suarsana et al.	2019	80	18.849	4.342	.441	0.0007	35.29
Suarsana et al.	2019	79	18.849	4.342	.443	0.0008	35.03
Afridiani et al.	2020	71	-	1.952	.229	0.0348	16.24
Ismail et al.	2020	64	-	10.99	.813	0.1580	52.03
Simbolon	2020	60	-	.109	.014	0.1609	0.86
Budikusuma et al.	2021	66	-	16.679	.902	0.2365	59.51
Sari et al.	2021	60	-	3.45	.413	0.0000	24.76
Puspita and Dewi	2021	68	-	41.12	.981	0.3200	66.71
Saeaswati et al.	2021	28	-	2.702	.468	0.0028	13.11
Suriani and Devita	2021	63	-	.140	.018	0.1580	1.13
Amin et al.	2021	188	-	.007	.001	0.1721	0.10
Juhaeriah et al.	2021	60	-	-	.507	0.0084	30.42
Mawarti et al.	2018	47	6.674	2.583	.359	0.0031	16.89
Sari et al.	2021	55	2.955	1.719	.230	0.0344	12.64
Budiono and Wardono	2014	50	-	2.57	.348	0.0046	17.39
Ibrahim et al.	2017	73	-	7.091	.644	0.0522	47.00

Table 6. Continued

Author	Year	N	F	t	r	$(r-\check{r})^2$	$N \times r$
Fitri et al.	2017	64	-	2.773	.332	0.0069	21.26
Mawarti et al.	2018	47	-	2.36	.332	0.0070	15.60
Utami	2016	48	-	.18	.027	0.1512	1.27
Divrik et al.	2020	41	-	3.14	.449	0.0011	18.42
Divrik et al.	2020	43	-	4.48	.573	0.0249	24.65
Divrik et al.	2020	42	-	2.43	.359	0.0032	15.06
Dinda et al.	2021	50	-	24.1	.961	0.2978	48.05
Kahar et al.	2018	18	-	32.806	.992	0.3327	17.86
Febriani et al.	2019	76	-	4.983	.501	0.0074	38.09
Febriani et al.	2019	76	-	2.919	.321	0.0088	24.42
Huda et al.	2020	50	-	4.013	.501	0.0074	25.06
Nuralifah and Hidayah	2021	26	-	17.23	.962	0.2987	25.01
Rodli et al.	2022	20	-	1.839	.398	0.0003	7.95
Syafwan et al.	2016	31	-	5.32	.697	0.0792	21.60
Kuswanto et al.	2017	32	-	1.774	.304	0.0125	9.71
Susantiet et al.	2022	32	-	2.468	.405	0.0001	12.97
Fauziah et al.	2022	60	-	4.420	.499	0.0070	29,93
Tamami et al.	2017	70	-	.063	.008	0.1663	0,53
Helmi et al.	2017	65	-	2.880	.339	0.0059	22,01
Fitriyani et al.	2019	72	-	.130	.015	0.1599	1,11
Diana and Makiyah	2021	33	-	21.1	.966	0.3031	31,87
Total		2632	-	-	-	3.838	975.14
Mean ($\check{r}$)		-	-	-	.415	0.083	-

From Table 6, it is found that the population correlation means $\check{r} = \frac{975.142}{2632} = 0.3705$, and the population correlation variance $\sigma^2 r$ is

$$\sigma^2 r = \frac{\sum(r-\check{r})^2}{2} = \frac{3.838}{2} = 1.919$$

Impact of Sampling

Determine the impact of sampling, and it can be done by (a) transforming the values of F and t into r, (b) calculating the mean population correlation ($\check{r}$), (c) calculating the variance ($\sigma^2 r$), (d) calculating the error variance sampling ($\sigma^2 e$), (e) estimating the variance of population correlation ($\sigma^2 \varrho$), and (f) determining the confidence interval. Perform the transformation of values from F and t to r and the calculation of the sampling correction can be seen in Table 6. Based on the transform of the score of F and t into r value, it has been obtained that $\check{r} = 0.3705$, population correlation variance $\sigma^2 r$ is 1.919, so the variance of sampling error is

$$\sigma^2 e = \frac{\left(1-\check{r}^2\right)^2}{N-1} = \frac{\left(1-(0.3705)^2\right)^2}{2632-1} = 0.000283.$$

Thus, the impact of sampling error is $\frac{\sigma^2 e}{\sigma^2 r} \times 100\% = \frac{0.000283}{1.919} \times 100\% = 0.015\%$.

The smaller percentage of error in sampling indicates that the possibility of error bias due to errors in sampling is getting smaller. The calculation results show that the population correlation $\sigma^2 r$ is 1.919, and the variance of sampling error $\sigma^2 e$ is 0.000283. The percentage of sampling error is 0.015%. This result shows that the error bias due to errors in sampling in the study of the effect of worksheets on problem-solving ability is relatively tiny.

In addition, in meta-analysis research, it is necessary to estimate the confidence interval to see whether the mean correlation of the effect size calculations is within the acceptability limit. Meanwhile, before determining the confidence interval, first estimate the correlation variance $\sigma^2 \varrho$ as follows

$$\sigma^2 \varrho = \sigma^2 r - \sigma^2 e = 1.919 - 0.000283 = 1.918717.$$

After obtaining the correlation variance $\sigma^2 \varrho = 1{,}918717, and\ then$ the confidence interval is carried out using the formula $\check{r} \pm 1.96\sqrt{\sigma^2 r}$, namely

$$\check{r} \pm 1.96\sqrt{\sigma^2 r} = 0.382 \pm 1.96\sqrt{1.919} = 0.382 \pm 2.715,$$

so that the confidence interval is in the interval −2.715 to 3.097. The calculation results show that the mean population correlation is $\check{r} = 0.3705$, and this quantity is in the interval −2.715 to 3.097. So, it can be concluded that there is a positive influence between worksheets on students' problem-solving skills.

Discussion

The purpose of a meta-analysis study is to analyze data derived from primary sources or sources derived from article publications in journals and proceedings. The meta-analysis results can be used to support or refute the hypothesis made by previous researchers, namely, that worksheet has a positive effect on "problem-solving skills." In addition, this meta-analysis study provides specific instructions for further research. This research can serve as a basis for determining whether a learning worksheet should be developed to improve students' problem-solving abilities.

From the meta-analysis results, the average effect size is 1.281, with a very high category in the interval. Therefore, it can be concluded that worksheets positively affect students' problem-solving skills. The positive effect of worksheets on problem-solving ability is in the very high category. In addition, the analysis results show that the percentage sampling error is 0.015%, so the possibility of bias in the conclusions of a study due to sampling error is becoming smaller. This result means that previous research shows that it can be generalized to the population and scientifically justified. The results from this meta-analysis study suggest that the worksheet can improve problem-solving skills. However, much previous research shows that the worksheets used can be used in conjunction with the learning approaches, learning models, and teaching materials to improve problem-solving skills.

Several researchers have researched worksheets related to the learning approach. Regarding worksheets with an investigative learning approach (Puspita & Dewi, 2021), the results showed that the average use of this worksheet was 70.37, which was higher than the non-use of the worksheet, which received an average of 20.1. In addition, there is also the study of worksheets with an inquiry approach (Rahmah et al., 2020; Ruthven, 2012). Another example of using a learning approach is to use a worksheet with a scientific method (Ernawati & Sujatmika, 2021; Fajarianingtyas et al., 2019; Zakaria & Hidayah, 2015) and a worksheet with a realistic mathematics teaching approach (Budiono & Wardono, 2014; Ismail et al., 2020).

Worksheet research with learning models was conducted using reciprocal teaching (Febriani et al., 2019). It was found that the worksheet used had an average problem-solving ability of 71.84, higher than that of the worksheet not used, 51. The worksheet using the Process Oriented Guided Inquiry Learning (POGIL) approach found that the worksheet using the POGIL learning model was able to supplement learning in aspects of problem-solving subject matter opportunities (Rosidah, 2013). Other research includes a worksheet with a guided discovery learning model (Laili et al., 2019; Nurahman et al., 2018), a worksheet with a discovery learning model (Astra et al., 2015; Junina et al., 2020; Suriani & Devita, 2021), and a worksheet with a conceptual understanding learning model procedures or CUPs (Ibrahim et al., 2017).

Previous research shows that worksheets are generally used as a learning medium with a different position than other learning media. Worksheets can be used as a primary learning resource and become the central learning tool in the classroom after the teacher and can complement the use of learning strategies by teachers. For this reason, worksheets are indispensable in a lesson and positively affect problem-solving skills.

Worksheets are one of the learning resources teachers can create to support learning activities (Silver & Woolf, 2015; Utami et al., 2016). Worksheets can be designed and developed according to the conditions and situations of the learning activities they face (Sujatmika et al., 2019). Thus, teachers can use the worksheets for the learning process, and students can use them for independent learning. Apart from being a learning resource, the worksheet can be considered a media of learning (Hakim et al., 2019; Widodo et al., 2018) because learning media are a tool to convey messages or information for teaching or learning purposes. This feature is one of the functions and goals of worksheets. The worksheets the teacher creates are expected to be used by the students for independent learning. In conjunction with this condition, the worksheet becomes a source of learning and a learning medium depending on the learning activities designed by the teacher. Although student worksheets are positioned as a learning medium or learning resource for students, experts in the field agree that student worksheets have a positive effect on students' cognitive skills.

Worksheets must be prepared before learning to be used when conducting teaching and learning activities in the classroom (Long et al., 2017; Sepulveda-Escobar & Morrison, 2020; Tondeur et al., 2017). In preparing for learning, the teacher does prepare other learning materials, such as lesson plans. However, in general, the instructional materials that the teacher has designed must be adapted to the characteristics of the students so that they do not have problems during learning (Reiser & Gagné, 1982). Worksheets are designed and developed based on the conditions and situations of the learning activities they face, so when preparing worksheets for students, teachers cannot simply put them together. For this reason, when preparing worksheets to improve problem-solving skills, it is necessary to consider the stages of problem-solving when collecting worksheets. These stages can be addressed in alternative responses to sample questions and guided practice characteristic of problem-solving worksheets.

The use of worksheets in learning is part of teachers' efforts to achieve learning objectives well (Hwang & Tu, 2021; In'am & Hajar, 2017; Usmeldi et al., 2017). A worksheet is a material prepared and used by the teacher to support the implementation of teaching and learning activities in the classroom (İnan & Erkus, 2017; Maman & Rajab, 2016). Worksheets in learning can function as instructional materials that minimize the role of teachers but activate students more (Amalya et al., 2021; Russo & Hopkins, 2017). Worksheets can contain material, summaries, and tasks for students to complete (Romli et al., 2018). Student tasks included in worksheets may be sample questions or guided practice questions. These worksheet tasks are prepared to address the stages of problem-solving so that when students are faced with formative and summative tests, they are already in the habit of solving problems. Thus, the worksheet influences the ability to solve problems.

The results of this meta-analysis show that there is a positive effect between worksheets and problem-solving skills. These results are consistent with previous research stating that using worksheets in learning affects problem-solving skills (Ibrahim et al., 2017; Nuralifah & Hidayah, 2021; Rodli et al., 2022; Rosidah, 2013). A study by Ibrahim et al. (2017) showed that using worksheets with supported conceptual understanding procedures (CUPs) positively influenced problem-solving skills. In the research conducted by Nuralifah and Hidayah (2021), it was found that the use of worksheets based on IDEAL Problem Solving-based worksheets significantly increased students' pre-test and post-test scores, making the developed worksheets practical to use. The research findings of Rodli et al. (2022) showed that worksheets based on procedural fluency could promote students' problem-solving skills. Similarly, the research results of Rosidah (2013) showed that students have better problem-solving skills when learning using the Process Oriented Guided Inquiry Learning (POGIL) model with the help of worksheets, compared to traditional learning.

However, the results of previous studies still need to summarize the results of previous studies related to worksheets and problem-solving. For example, the studies of Ibrahim et al. (2017), Nuralifah and Hidayah (2021), Rodli et al. 2022, Rosidah (2013), and other researchers have not been able to provide an overview of the magnitude of the effect of worksheets on problem-solving skill. Hence, our current research is different from previous studies that have been conducted. By conducting a meta-analysis, we found the effect size, summarized the results of (at least) two studies, and described the magnitude of the worksheet's effects on students' skills.

Conclusion

In this study, forty studies were analyzed, and forty-five data comparisons were examined. The assessment of the effect of the worksheet on students' ability to solve problems is 1.281, indicating that the effect of the worksheet on the ability to solve problems is in the "very high" category. This effect was obtained in worksheet research using secondary school students, a large sample size (more than 30 students), and a random sample. For further studies, researchers need to examine developing worksheets adapted to the form of learning, the characteristics, and the students' environment.

From the results of this study, it can be concluded that worksheets positively influence students' problem-solving skills. This study contributes to the literature on worksheets related to students' problem-solving skills. One of the most important contributions to the literature on worksheets and problem-solving skills is that worksheets positively affect problem-solving skills based on research findings. Thus, this meta-analysis study's results show a positive effect between worksheets and problem-solving skills.

Recommendations

From this study, there are several recommendations for further research in the future. Over time, there will undoubtedly be many studies by new authors on the effects of worksheets on students' problem-solving skills. This fact may increase the number of studies analyzed from previous meta-analytic studies. In other words, more research is needed to consider the effects of worksheets on various cognitive skills or to examine the factors that may influence the improvement of students' problem-solving skills. Researchers also hope to develop a worksheet that improves students' problem-solving skills. For educational practitioners, in this case, teachers in schools, many research results show a significant influence between worksheets and problem-solving skills. They can use worksheets as learning aids that make it easier for students to understand problems and improve students' problem-solving skills.

Limitations

This study measures only quantitative research results with the type of research and development, experimental and quasi-experimental. In addition, the study's results must include the mean, sample size, and standard deviation, or at least write down the t-test, F-test, and r-coefficient in addition to the sample size. In other words, for studies that do not include this information, no meta-analysis is performed in this study. For this reason, the results of this study are only used as a basic idea for further research. From this study, the suggestion is to develop worksheets to improve students' problem-solving abilities.

In addition, in this study reliability was not done statistically. this was done for reasons from the researcher, such as the researcher's belief that the article used had gone through a lengthy assessment process from the journal editor and reviewer before the article was published in a journal or proceedings.

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Widodo: Conceptualization, design, quantitative research, statistical tests, editing/reviewing, supervision, final approval. Wijayanti: Literature search, editing/reviewing, supervision, final approval. Irfan: Conceptualization, design, qualitative research, making codes, editing/reviewing, supervision. Pusporini: Conceptualization, design, selected literature, analysis/ interpretation, writing. Mariah: Editing, supervision, final approval. Rochmiyati: Editing/reviewing, critical revision of manuscript, final approval.

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